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ADVANCES IN SEWAGE TREATMENT IN THE PERIOD FROM OCTOBER 1, 1951 TO SEPTEMBER 1, 1952

Progress Report of the Committee of the
Sanitary Engineering Division on
Sewerage and Sewage Treatment

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ADVANCES IN SEWAGE TREATMENT IN THE PERIOD FROM OCTOBER 1, 1951 to SEPTEMBER 1, 1952

Report of the Committee of the
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This report of the Committee on Sewerage and Sewage Treatment covers a period of approximately one year beginning October 1, 1951.

The annual review of the literature on sewage and waste treatment and stream pollution by the Committee on Research of the Federation of Sewage and Industrial Wastes Associations (1) continues to summarize the art, principally from the research, laboratory, and operating standpoints, as it has done each year since 1933.

The 1951 review covered a record number of articles: 201 on sewage treatment; 164 on industrial wastes; 94 on radioactivity; and 256 on water pollution-- a total of 715 references compared with 661 in the 1950 review. The literature reveals steady progress, especially in improvements to and modifications of existing processes and a more complete knowledge of the theory and mechanism of the various treatment processes. Among the developments are the modifications of the activated sludge process permitting increased loadings at lower construction and operation cost with moderate reductions in treatment efficiency; flotation concentration of sludge; phenol oxidation by chlorine; the apparent rather low public health hazard in the use of sewage and sludge for irrigation and fertilization of crops; the possible recovery of vitamins from sludge; the use of the membrane filter in speeding up bacterial analyses; and the trend toward stream quality standards rather than effluent quality.

In view of the exhaustive nature of the Federation Committee Review from the standpoint of the literature, this ASCE report is directed chiefly to the engineering phases of the art and to topics which are authenticated but not always published.

POLLUTION REPORTS AND SURVEYS

United States Public Health Service Water Pollution Reports

In a country wide survey, the U. S. Public Health Service under Public Law No. 845 has continued to issue reports on pollution conditions in the main drainage basin areas in the United States. Summary reports for the following drainage basins have been released: California Drainage Basins (2); Colorado Drainage Basin (3); Great Lakes Drainage Basin (4); Missouri River Drainage Basin (5); New England Drainage Basins (6); North Atlantic Drainage Basins (7); Pacific Northwest Drainage Basins (8); Tennessee River Drainage Basin (9); Upper Mississippi Drainage Basin (135); Western Gulf Drainage Basin (136); Southeast Drainage Basins (137); Southwest-Lower Mississippi Drainage Basins (138); Ohio River Drainage Basin (139). These cooperative State-Federal reports present information as of 1950 regarding pollution in the basins, prevention measures in effect, and prevention measures required.

The Public Health Service has issued a report on "Bathing water Quality and Health - A Study on the Chicago Lake Front" (10). Various regulatory agencies throughout the country have allowable coliform density standards varying from 50 per 100 ml. to 2400 per 100 ml., with most standards in the 500 to 1,000 per 100 ml. range. This wide variance in standards is probably due to the lack of acceptable evidence coordinating coliform density of bathing water with the occurrence of human disease. This report is the first of a series of planned similar studies with waters of different quality. In the survey, reliance was placed principally on the occurrence of minor skin, eye, ear, respiratory, and gastrointestinal illnesses. The survey covered a 63-day period on two different beaches on Lake Michigan in Chicago. The median coliform densities (M.P.N. per 100 ml.) were 91 on the north beach and 180 on the south beach. These were lower than anticipated and the water at both beaches was of relatively good quality. Although the water at the south beach was twice as polluted as at the north beach, there was very little difference in the number of illnesses found. The report concludes that bathing in Lake Michigan shore waters with a median coliform density of 180 per 100 per ml. presents no general hazard to public health. The variations found in the coliform counts during the test period indicate the fallacy of attempting to rate bathing waters on the basis of a very few samples. They also indicate that any standard for bacterial quality of bathing waters should be based on the mean results of an adequate number of samples, with a permissible percentage in excess of a specified value, rather than on the rigid basis of an absolute maximum which may not be exceeded. Further studies are necessary to correlate the ranges of water quality with different illness hazards to bathers.

Illinois River Pollution

In February, 1952, The Sanitary District of Chicago issued a memorandum (11) in support of Bills before Congress for diversion of an additional 2,000 c.f.s. from Lake Michigan at Chicago. The memorandum states that the additional 2,000 c.f.s. diversion, increasing the present 1,500 c.f.s. to an annual average of 3,500 c.f.s., would result in a clean stream throughout the entire Illinois Waterway, from Chicago to the Mississippi River. Despite the fact that The Sanitary District of Chicago is now providing complete treatment for practically all of its sewage, the upper 50 to 60 miles of this waterway remains in an unsatisfactory condition. With the diversion now authorized for navigation, only about 75% of the dissolved oxygen needed is available to supply the remaining oxygen demand of the treated sewage.

By December 31, 1951, The Sanitary District of Chicago had expended a total of approximately $281,000,000 towards sewage treatment, of which $126,000,000 was for sewers, $141,000,000 for treatment works, and $14,000,000 for pumping stations. The annual cost of operating and maintaining these facilities is currently about $11,500,000.

Complete treatment of the sewage of the Sanitary District on an annual average basis, will produce the following approximate results:

Population treated - Human	4,500,000
Industrial Wastes Equivalent	3,000,000
Total population equivalent, treated:	7,500,000

Sewage flow	1,100 million gallons per day
Sewage solids, dry basis	830 tons per day
Solids removed, 90 per cent	747 tons per day
Solids to canal:	83 tons per day

BOD in raw sewage	1,250,000 pounds per day
Reduction in BOD, 90 per cent	1,125,000 pounds per day
BOD in treated effluent:	125,000 pounds per day

Salt Lake City Pollution Survey

Studies (12) made at Salt Lake City, Utah, refute the popular assumption that harmful bacteria do not thrive in the waters of the Great Salt Lake. Bacteriological tests carried out with a mobile laboratory indicated extensive evidence of sewage pollution around the lake, extending a considerable distance from the City outfall. The studies, expected to lead to the establishment of treatment plants by Salt Lake City and other communities along the shore, stem from recognition that the half-century old practice of pumping raw sewage into the 50 x 75 mile Great Salt Lake constitutes a health hazard to the lake beaches and some 300,000 persons in Utah's most populous region.

LEGISLATIVE DEVELOPMENTS

State Legislative Action in 1951

The F.S.I.W.A. Legislative Analysis Committee prepared a review (13) showing action taken in 33 states on matters relating to water pollution control. In 1951, four states (Maine, North Carolina, Ohio, and Vermont) joined the growing list setting up special commissions to deal with water pollution control.

The Arkansas legislature authorizes 20 or more residents of territories contiguous to streams or lakes being polluted to file a petition with the Game and Fish Commission which shall proceed in Court against anyone guilty of such pollution.

Diversion of Treated Effluent from Lakes Because of Algae Growths

At Madison, Wisconsin (14), a State Supreme Court ruling upheld a Circuit Court judgment compelling the city to divert its sewage plant effluent from lakes in the vicinity. Legislation passed in 1949, in effect, prohibited Madison from continuing to discharge its effluent into the lakes. The Madison Metropolitan Sewerage District unsuccessfully challenged it as unreasonable and unconstitutional. Madison must now divert its effluent to reduce the nuisance-producing algae blooms in the lakes, at a cost of several million dollars, even though the city has a modern sewage treatment plant providing secondary treatment. The plant effluent contains inorganic nitrogen and phosphorus in sufficient quantities to contribute substnatially to the growth of algae in the lakes.

National Water Resources Policy

The Federal Water Pollution Control Act of 1948 and a subsequent report by the President's Water Resources Policy Commission, "A Water Policy for the American People," were discussed by L. R. Howson, M. ASCE, in a paper (15) presented before the 24th Annual Meeting of the F.S.I.W.A. According to a U.S.P.H.S. survey, the following increase in sewage treatment facilities has occurred between 1920 and 1950:

Year	No. of Plants	Million Population Served	% of Urban Population Served
1920	1000	10	18
1950	6700	60	65

While this growth of sewage treatment facilities is gratifying, much still remains to be done. The urban population has doubled in the last 35 years and is currently increasing at the rate of approximately 1,500,000 per year. The increase in population density will require not only more treatment plants but also higher degrees of treatment. Mr. Howson believes present legislative controls over stream pollution are adequate to bring about necessary abatement and that the local governments should have the responsibility for correcting pollution without recourse to grants from the Federal government. The President's Commission recommended that plans for waste treatment plants should include reasonable provision for recovery of by-products and re-use of effluents, and further that "if the Federal-State-Local cooperative pollution program fails to provide the country with clean rivers within a period of ten years, the 1948 Act should be reconsidered with a view to providing for Federal enforcement." Mr. Howson considers this ten-year period unreasonably short and that even if the accelerated rate of past construction continues, a period of about 20 years is required. Mr. Howson also questions the economic merits of the Commission's recommendations as to by-product recoveries, because "in most cases, sludge cannot be packaged and sold except at a material economic loss." In his opinion if fertilizer production is tied into all future sewage treatment projects, it would be a serious deterrent to the present high rate of plant construction. Mr. Howson advocates a realistic approach, recognizing that while sludge and effluent may have some value in individual cases, in the vast majority of cases any revenue therefrom can only be secured by expenditures materially in excess of the revenue. Mr. Howson concludes that sewage treatment is within the economic reach of all polluters, as most communities can finance sewage treatment at a cost of approximately 1¢ per capita per day, including amortization of the cost and operating expense. If waste treatment cannot be sold at so low a cost, people have not been sufficiently educated, either as to the requirements or the cost.

INTERSTATE AND OTHER JOINT COMPACTS

Joint sewage treatment undertakings are increasing as contiguous political subdivisions with sewage disposal problems to solve are joining to obtain the benefits to all concerned. Among these are Bristol, Virginia and Bristol, Tenn.; joint action by several communities in Orange County, California; the East Bay Municipal Utility District in the Oakland-Berkeley area; the Metropolitan Sewer District for Covington, Newport, and 13 contiguous communities in Kentucky; the Allegheny Sanitary Authority for Pittsburgh and adjoining communities. Successful joint agreements of longer standing include the "Joint Meeting" plan in the Elizabeth, New Jersey area, the Los Angeles County Sanitation Districts, and the Minneapolis-Saint Paul Sanitary District. According to data compiled by the U. S. Dept. of Commerce, there were 65 Sanitary Districts in the United States in 1951 (80).

Ohio River Valley Water Sanitation Commission

At the close of the fiscal year 1951, 39% of the sewage waste of cities in

the eight states forming this commission was receiving some treatment. Municipalities whose population totals another 8% have treatment works under construction. Established in 1948, the members of this interstate compact include Illinois, Indiana, Ohio, Kentucky, Pennsylvania, New York, West Virginia, and Virginia. The Commission issued its Third Annual Report (17) in 1951. The constitutionality of this interstate compact was upheld by the Supreme Court. The Commission is engaged in an active education program among communities and industries. Edward J. Cleary, M. ASCE, is Executive Director and Chief Engineer for the Commission with headquarters at 414 Walnut Street, Cincinnati, Ohio.

On April 2, 1952, the Commission (18) adopted sewage treatment requirements for communities along the 160-mile stretch of river between Huntington, West Virginia and Cincinnati, Ohio. These requirements include:

(1) Substantially complete removal of settleable solids.
(2) 45% removal of suspended solids.
(3) Coliform reduction of 90%, May through November, and 80%, December through April.

Interstate Sanitary Commission (New York, New Jersey, and Connecticut)

After 16 years of work, this interstate compact foresees the accomplishment of the first phase of its program. By mid-1954, there will be practically no raw sewage in any Class A waters of its area (19). Once this goal is attained, the remaining problems will involve control of special industrial wastes and modernization of older sewage treatment plants in the area.

New England Water Control Commission

Vermont (20) and New Hampshire (21) have joined Connecticut, Massachusetts, New York, and Rhode Island as official members of the New England Water Control Commission. The Commission has issued a report (22), "Industrial Wastes in the New England Interstate Water Pollution Control Compact Area," which states there were 1,939 plants producing liquid wastes having a population equivalent of nearly 5 million, with approximately 90% of this load discharged without treatment. Textile mills caused 46% of the region's industrial pollution. The extent of construction required to correct the industrial waste problem in New England is shown in the U.S.P.H.S. New England Drainage Basins Report (6), and comprises 671 new plants, 69 enlargements, and 8 replacements of existing works.

International Joint Commission on Boundary Waters

A report of the International Joint Commission studies of 1946-1948 on the pollution of boundary waters was issued in 1951 (23), covering the pollution situation with special reference to conditions in the Detroit and Niagara Rivers. It analyzed waste disposal practices and problems of some 60 municipalities and 100 industrial plants. The report contains recommended water quality standards which are to be considered tentative and subject to revision as developments warrant. An estimated expenditure of $125 million would be required of municipalities and industry in the pollution abatement program recommended, in addition to what has already been spent by Detroit, Buffalo, and other municipalities and industry.

SEWAGE TREATMENT PROJECTS

In 1951, contracts for sewerage construction work totalled $335 million,

16% over 1950 (24). During the first half of 1952, municipalities in 36 states awarded contracts for the construction of 255 sewage treatment plant projects, involving a cost of $69 million (25). Of these 255 projects, 147 are new plants, to cost about $35 million and the remaining 108 consist of additions to or replacements of existing plants. The present status of some of the larger projects is reviewed below:

Cincinnati, Ohio

Construction of Cincinnati's Little Miami Sewage Treatment Plant, the first of four projected plants, was started in 1951 and was about 40% completed as of April, 1952 (26). Operation will probably begin in the summer of 1953. Plans are being drawn for construction of a second larger plant serving the heavy industrialized area of the city, with construction probably starting in 1955. The Little Miami plant was designed for approximately 30 mgd at a construction cost of approximately $4 million, and is a primary treatment plant equipped for chemical treatment of the sewage, with sludge disposal by digestion, elutriation, and incineration.

New York City

New York has completed three sewage treatment plants during the past year in its program which will eventually require 18 sewage treatment projects. Seven modern plants were in operation by the close of 1951 (27). During 1951, four additional plants were under construction, three of which have been completed: Hunts Point Plant (28); Rockaway Plant (29); and Owls Head Plant (30). At the close of 1951, about 45% of the city's sewage was receiving treatment and this figure will increase to about 70% when the four additional plants are all in operation.

According to information received from W. Donaldson, M. ASCE, the Owls Head 160 mgd short-period activated sludge plant, serving an ultimate population of 1,200,000, was placed in operation February 19, 1952. This $13 million plant is located in Brooklyn and will help protect the bathing beaches at Coney Island and Staten Island. To meet local objections to the plant site, extensive precautions were taken to minimize odors by housing the aeration and settling tanks in one structure covering seven acres, with 15 ventilating fans having a total capacity of nearly 250,000 c.f.m., discharging through a tower.

The Hunts Point plant was placed in operation May 28, 1952, treating 120 mgd from a population of 700,000 in the Bronx area. It was a $22 million project (of which $16 million was for the plant and $6 million for intercepting sewers) and employs the lower cost "step-aeration modification of the activated sludge process" developed by the city. Sludge is digested and barged to sea. Sludge gas is recovered for power and heat.

The Rockaway plant was placed in service August 7, 1952. Designed for an initial capacity of 15 mgd, this $5 million plant serves the Rockaway peninsula with a resident population of 45,000 and a week-end summer population of 90,000. This plant also uses the short-period activated sludge process, without primary settling tanks and with an aeration period of only about two hours.

The fourth plant now under construction is the Oakwood 15 mgd short-period activated sludge plant, scheduled for completion in 1953. This will fulfill an agreement with the Interstate Sanitary Commission that adequate treatment would be given to all sewage discharged into Class A (recreational) waters before the end of 1953.

There is considerable discussion as to whether the name "activated sludge" should be applied to the treatment process used in these plants, even though

prefixed by the words, " modified", " short-period", or " high-rate." New York City developed the process under the name of " modified sewage aeration." Removals are expected to run about 80% of the suspended solids and about 75% of the B.O.D.

The 1951 average operating data for New York's 7 modern and 6 old plants (screening and chlorination) is summarized (27) below:

Sewage Treated	MGD
Activated Sludge Process	363
Chemical Precipitation Plants	66
Plain Sedimentation Plants	1
Fine Screenings Plant	30
Total all Plants	460
Total dry solids removed	336 tons per day
Sludge gas	1,422,300 c.f. per day
Power produced from gas	61,250 K.W.H. per day
Sludge dumped at sea	63,002 dry tons for the year
Sludge air dried	7,668 dry tons for the year
Cost of treatment per million gal.	$20.09

Arlington County, Virginia

A contract totaling nearly $3 million was awarded (31) to construct a treatment plant for Arlington County, Virginia, just across the Potomac River from the nation's capital.

Camden, New Jersey

Contracts were let in 1951 for construction of a primary treatment plant at Camden, N. J. (32), at a cost of approximately $5.5 million. The total cost of the project, including intercepting sewers and pumping stations will be about $12 million. Construction was about 35% completed early in 1952.

Boston, Mass.

The $7.5 million Nut Island Treatment Plant (33) in Boston went into operation in December, 1951, giving primary treatment to 112 mgd. Chas. A. Maguire and Associates are designing a complete sewage disposal system for the Boston Harbor area, with a total estimated construction cost of about $31 million, to serve Boston and 32 nearby communities. Construction work on parts of this program is already under way with 1958 set as the goal for completion.

Philadelphia, Pa.

The Philadelphia Department of Engineering (34) selected " modified aeration" as a compromise between primary treatment and activated sludge treatment for the rebuilt Northeast Plant which was placed in operation on April 6, 1951. This $14 million plant provides primary settling, aeration (using 0.5 cu. ft. of air per gal. of sewage), and final settling. In the early operation, rather low removals were obtained, approximately 46% of the B.O.D. and 56% of the suspended solids. These removals have since increased to 80%, according to information supplied by M. Barofsky, M. ASCE. The remodeled plant has a capacity of 125 mgd and is provided with sludge digestion and lagooning of the sludge. Construction work on the Southeast and on the Southwest Works is well along. The city planned to receive bids on about

$16 million worth of work on treatment works and intercepting sewers in the year ending September 30, 1952.

Pittsburgh, Pa.

Preparation of plans and specifications (35) for a $60 million sewage treatment system for Pittsburgh and adjoining municipalities is about a year behind schedule. Part of this work is being done by the Allegheny County Sanitary Authority and part by Metcalf & Eddy. Plans and specifications for over $20 million worth of work have been completed. The treatment plant plans will incorporate the Laboon process of sludge concentration by flotation according to J. F. Laboon, M. ASCE., and F. L. Flood, M. ASCE. The present design basis for sludge disposal is as follows: The sludge and scum will be heated to 95°F. and concentrated on a batch basis for five days in rectangular concentration tanks equipped with screw conveyors for removal of the concentrated sludge, expected to average about 20% solids. Sixteen concentration tanks will be required, insulated and provided with radiant heating. The concentrated sludge from the screw conveyors will be pumped with Moyno progressing-cavity pumps such as those used in the food industry for moving semi-solid materials like potato salad. They will deliver the concentrated sludge to tanks in the incinerator building where equipment will be provided for adding supplementary fuel in the form of fine coal puddled with the sludge. This will eliminate the vacuum filtration process and incinerate the sludge directly, taking advantage of the low price coal available in the Pittsburgh area for the supplementary fuel requirement.

Charleston, West Virginia

Complying with orders issued by the State Water Commission in 1950, Charleston, West Virginia will construct (36) a $12 million sewage treatment plant and appurtenant facilities. This project was started in the summer of 1952.

Miami, Florida

After a delay of many years, the Miami property owners have voted (37) to spend $27 million to end the dumping of raw sewage into Biscayne Bay. Miami's present sewer system serves only about 55% of the population of 247,000, producing about 47 mgd of raw sewage which empties through 70 outfalls. The project proposes to collect the city's sewage at two main pumping stations, discharging through a 72-inch force main under the Bay to a treatment plant on Virginia Key. The plant will be of the modified activated sludge type (step-aeration or biosorption (58)) with separate sludge digestion followed by dewatering and incineration. The plant effluent will be dispersed in 18 feet of water, 4600 feet out in the ocean.

Tampa, Florida

Tampa, Florida (38) is fulfilling a 20-year goal by building a complete sewer system and treatment plant at a cost of $12 million, financed entirely by means of revenue certificates through sewer-service charges. The 36 mgd primary treatment plant is designed for an anticipated 1970 population of 235,000. Sludge digesters and drying beds are provided. Chlorination of the effluent is planned with an outfall extended 3,750 feet out into the Bay.

Nashville, Tenn.

By referendum vote Nashville, Tenn., has approved (39) the issuance of revenue bonds for the construction of intercepting sewers and a 40 mgd primary treatment plant to cost approximately $11 million and to be financed by an increase in water rates, serving a population of 335,000 and eliminating 26 outfalls discharging directly into the Cumberland River.

Oklahoma City, Oklahoma

A new 10 mgd activated sludge plant and sewer system totaling over $4.5 million is over half completed at Oklahoma City (40).

Chicago, Illinois

Construction of the Sanitary District of Chicago intercepting sewer system is nearly complete (41) (11), with only minor extensions needed for areas recently annexed to the District. In 1951, contracts were awarded for $6.4 million for new work at the 800 mgd West-Southwest sewage treatment works, $4.8 million worth of work was completed, leaving $8.7 million still under way. Contracts for all remaining work at this plant are expected to be awarded during 1952.

Waterbury, Conn.

A $1.5 million, 15 mgd primary treatment plant with sludge filtration and incineration, combined with incineration of municipal refuse, began partial operation at the close of 1951 (42) and was in full operation in 1952.

Wilmington, Delaware

An $8 million, 43 mgd sewage treatment plant to serve Wilmington and adjoining areas (42) is now under construction with completion scheduled for 1953.

Los Angeles, California

The new 245 mgd short-period activated sludge plant at Hyperion (43) which was placed in full operation in 1951, has been going through the usual "trials and tribulations" stage encountered in placing most large plants in operation. Excessive formation of froth has been experienced on the aeration tanks according to information supplied by W. A. Schneider, A.M. ASCE, and F. L. Flood, M. ASCE. A system of sprays supplemented by the use of defrothing agents has been developed to control the frothing. A spray system consisting of 1,680 fan type nozzles spaced at 7 ft. centers has been installed to control the froth from a tank surface of 300,000 sq. ft. Approximately 3,500 gpm of plant effluent is used as spray water, resulting in a discharge of about 2.1 gpm per nozzle at a pressure of 10 lb. per sq. inch. The installation successfully controls the froth during 20 hours per day. During the remaining 4 hours of the day, a gradual build up of froth ensues. It has been determined that an increase of about 50% in spray water supply will effect control during this 4-hour period and an additional pump is to be installed for this purpose. At the present time, during the 4 hours of critical froth production, chemical defoamers are added to the spray water at the rate of 25 ppm or about 0.7 ppm based on sewage flow. This eliminates the froth during the critical period. During the critical 4-hour period, it is only necessary to operate the chemical defrothing pump 20 min. per hour. Defrothing agents which have been used successfully are Swift and Company Sanitary Defoamer, General Petroleum Defoamer SPL-51097-C, Treolite Company VezD-13, and Nalco 71-D-5.

Some difficulty has also been experienced in maintaining aerobic conditions in the return sludge used in the short-period activated sludge process. The secondary treatment system, including the mixed liquor channel, aerator tanks, aerator effluent channels, final tanks, final tank sludge hoppers, return sludge channels, has been checked with an oxidation-reduction potentiometer. As the Hyperion Plant is served by a long outfall sewer wherein septic conditions prevail during the last few miles before entering the plant, the sewage is well seeded with facultative and anaerobic organisms and has a tendency to go anaerobic very easily. Oxidation-reduction potential measurements have shown the lower end of the aerators to be in good aerobic condition when air is applied at the rate of approximately 0.8 cu. ft. per gal. of sewage. By the time the sewage has reached the final tank, it is still in fair condition but the sludge settling out rapidly deteriorates towards an anaerobic condition. The sludge in the final tank hoppers is anaerobic even though it is continuously removed. The return sludge channels are aerated but it is impossible to use enough air to return this sludge to aerobic condition prior to being introduced to the incoming primary effluent.

From the inception of operation of the Filter Building, the filtering characteristics of the elutriated digested sludge obtained at Hyperion have been exceedingly poor. Grease content and reduction of volatile solids in the digested sludge produced at Hyperion are approximately equal to that of sludge produced at San Francisco and San Diego and, therefore, conform to a regional pattern. Sludge filtering difficulties are not apparent at San Francisco and San Diego. One obvious difference in the sludge produced at Los Angeles and that of San Francisco and San Diego is that 80% of the Los Angeles sludge has a particle size 0.0029 in. or smaller, whereas San Francisco has 50%, and San Diego 60% particle size 0.0029 in. or smaller. As the stability of any suspensoid is related to particle size, it is believed that sludge composed of small sludge particles is harder to coagulate (the reverse of suspension) than sludge composed of large particles. The problem at Hyperion is one of basic difficulties and not one of manipulation in the filter room since it is impossible to obtain good filtering rates with the sludge produced there using the best laboratory techniques. When the sludge is dosed first with ferric chloride and then with lime (which is not normally used on elutriated digested sludge) good filter cake is produced at a rate of about 4 lbs. per sq. ft. per hr. However, due to the nature of Southern California soils, it has been impossible to market an alkaline fertilizer, so this phase of research and development was abandoned after about one month operation. Concentration and storage of elutriated digested sludge for a period of three or four days appears to hold considerable promise due to thickening of sludge and consequently greater filter yields. In the laboratory, considerable success has been obtained by the use of soil agglomerating agents derived from acrylic acid polymers (Krilium, etc.), but at present their use is not indicated because of excessive cost. However, in the laboratory 1% Krilium followed by 4% ferric chloride leads to heavy filter yields in the order of 7 lb. per sq. ft. per hr. This opens an interesting avenue of research.

The sludge cake from the filters is further dried in Raymond Flash-Drying equipment. The dried cake contains 2.25% nitrogen and 3.25% water soluble phosphate and therefore qualifies as a fertilizer under the State laws of California. A broker has a contract to dispose of the fertilizer which is sacked in 80 lb. bags. The material is extremely fine and dusty, making it somewhat difficult to handle, and from time to time marketing problems have developed because of the dustiness. Pelletizing equipment has been purchased and is now being installed, with operation expected by November 1, 1952.

During May and June, 1952, the Los Angeles works treated 221.9 mgd with a removal of suspended solids of 76.2% and of B.O.D. of 74.8%. The plant effluent contained suspended solids 76.5 ppm and B.O.D. 52.5 ppm. The average use of air was 0.77 cu. ft. per gal. of sewage. Chlorination began on May 15, 1952. The average use of chlorine was 7.5 tons per day. During June, 1952, all stations in Santa Monica Bay passed the requirements of the California Department of Public Health for recreational purposes. Heat-dried sludge produced averaged 1,819 tons per month, although sludge sales are reported to be around 75 tons per day.

Oakland, California

The $23.5 million interceptor sewer and sewage treatment plant program undertaken by the East Bay Municipal Utility District (44) was practically completed during 1951, going into operation November 15. The $12.5 million primary treatment plant discharges its effluent through an outfall extending 2,000 feet into San Francisco Bay. The cities served are Oakland, Alameda, Albany, Berkeley, Emeryville, and Piedmont.

San Francisco, Calif.

The new 150 mgd North Point primary treatment plant (45) has been completed, serving an estimated 1960 population of 835,000 in North Point region in San Francisco. The design flow basis was 65 mgd dry weather and 150 mgd wet weather. Sludge is pumped through a 10-inch pipe line to the new Southeast Plant six miles away where it is digested, elutrinated (between the first and second stages of digestion as well as the usual final countercurrent elutriation), filtered, and dried for fertilizer. The new Southeast Plant (26 mgd dry weather flow) will also dry the filter cake from the Older Richmond-Sunset Plant, the sludge cake being hauled by truck. Both new plants are expected to be in operation in 1952.

Portland, Oregon

Portland's $17 million sewerage system (52) was 80% completed in July, 1952. The primary treatment plant went into partial operation during the latter part of 1951 for part of the city. The plant is equipped with mechanically cleaned 1-inch bar screens and screenings grinders, grit chambers, rectangular settling tanks, and sludge digestion. The digested sludge is returned to the plant effluent for discharge to the Columbia River, which is always super-saturated with oxygen and carries a large volume of water (ranging from 35,000 to over 100,000 c.f.s.) at a high velocity. The purpose of the plant is primarily to eliminate local nuisance conditions in the Willamette River which flows through the city before it empties into the Columbia about three miles away.

ENLARGEMENTS OF EXISTING PLANTS

Among the existing plants which are being rehabilitated or enlarged are those of: Indianapolis, Indiana; Charlotte, North Carolina; Denver, Colorado; Baltimore, Maryland; Washington, D.C.; Columbus, Ohio; Dallas, Texas; Schenectady, New York; and Minneapolis-Saint Paul Sanitary District.

Indianapolis, Ind.

Indianapolis (46) has purchased 200 acres of land for use as additional sludge lagoons for its activated sludge plant. Plans and specifications have

also been completed for aerated grit chambers, pre-aeration tanks, and primary sedimentation tanks, with construction planned for 1952 at an estimated cost of $2.5 million. Metcalf and Eddy have recommended provisions for use of either the step-aeration process or the biosorption process (58).

Charlotte, North Carolina

Charlotte, N. C. (47) has received authorization from the N.P.A. for a $2 million enlargement of the Sugaw Creek sewage treatment works.

Denver, Colorado

The original Denver, Colorado plant (48) built in 1937 has now been expanded to serve a population of 420,000, with an increase in capacity from 55 to 84 mgd. New equipment consists of two coarse screens, a fine screen, a grit chamber, an aerator, two settling tanks, two digesters, and venturi meters. The original design provided for primary sedimentation supplemented by aeration (15 min.) and flocculation (15 min.) with or without chemicals. In the new flow-plan the flocculation step is omitted and the aeration is continued to 30 min. The supernatant from the digesters is aerated for five minutes and then settled for 30 min. The settled solids are mixed with the incoming raw sludge to the digesters and the clarified supernatant liquor is aerated for another two hours after which it is returned to the inlet of the plant. Grease is collected and marketed. The water from the South Platte River, the receiving stream, is used for irrigation. The plant effluent is chlorinated using the old abandoned effluent filter beds as contact tanks.

Baltimore, Md.

Thirty acres of 40-year old rectangular low-rate filters at Baltimore (42) (49) were recently converted to high-rate filters by equipping them with rotary distributors. B. O. D. removals in excess of 80% have been obtained at rates up to 13.5 mil. gal. per acre per day. The additional equipment for increasing the load on the filters appears amply warranted, as B.O.D. removals averaging approximately 70% have been obtained with loadings up to 8,000 lb. of 5-day B.O.D. per acre-ft. daily. A $2.1 million sludge drying plant is under construction and scheduled for completion in 1952.

Washington, D. C.

The construction of four additional settling tanks and four additional sludge digestion tanks and a gas sphere have been completed (42) (50), and are in operation. The total cost of these additions was approximately $1.5 million. Ralph E. Fuhrman, M. ASCE, reports that equipment contracts have been let for sludge flash driers and sewage chlorinators totaling about $800,000. Structures to house this equipment will be advertised for bids this year at an estimated additional cost of $1.85 million. Future plans call for the installation of short-period activated sludge treatment at an approximate cost of $9.5 million dollars. The first $2 million of this has been authorized and should be under contract early in 1953. The total cost of these improvements will be approximately $13.5 million, scheduled for completion in 1957 or 1958.

Columbus, Ohio

Plans have been prepared (51) for sludge concentration tanks, for lengthening the aerators to give a 25% increase in volume, provisions for step-aeration, a grease separation unit, and an additional 100 ton incinerator at Columbus. About $2.6 million worth of plant additions were constructed in 1949

through 1951. Another $3 to $5 million worth of other plant expansion work is needed to relieve the overloaded condition of the present plant, where the flow is nearly 80 mgd through a plant designed for 60 mgd.

Schenectady, New York

The old Schenectady sewage treatment plant is being enlarged (42) at a cost of $1,335,000, with construction about 70% completed.

Minneapolis-Saint Paul, Minn.

After 13 years of operation during which the connected population increased by about 100,000, the sludge disposal facilities at the Minneapolis-Saint Paul Sanitary District primary treatment plant (53) were increased 33% during the year 1951 by the installation of two additional vacuum filters and one additional multiple-hearth incinerator at a cost of approximately $200,000.

SOME DESIGN DEVELOPMENTS

Treatment Processes

Recently a series of articles have appeared dealing with basic design considerations for the different sewage treatment processes. J.J. Gilbert, M. ASCE, (54) discussed design data and equipment for sedimentation. The much used and abused septic tank has received considerable study by the U. S. Pub. Health Service at Cincinnati (55). The importance of individual household sewage disposal systems in American sewerage practice is not always recognized. It has been estimated that as of 1945, some 17 million persons were served by individual home sewage disposal systems compared with 75 million persons served by public sewer systems of which only 47 million were served by municipal sewage treatment works. Basic studies of the factors involved in proper design and satisfactory operation of household sewage disposal systems have received little attention. For the past several years, the U. S.P.H.S. has been conducting studies under joint sponsorship with the Housing and Home Finance Agency to determine the facts about septic tanks and ground absorption systems under various loadings and conditions, with the following findings to date: Two compartments are slightly more efficient than one; more than two is not economically justifiable; tanks made of large diameter sewer pipe perform satisfactorily and may be cheaper than rectangular ones; probably the most trouble with septic tanks is due to ineffective soil absorption of the effluent; to determine the percolating area required, bore several 4-in. auger holes in the ground as deep as the drainage trenches, saturate the soil with water, then put in each hole a 6-inch depth of clean water and note the time it takes to fall one inch. The inches per hour of effluent applied should not exceed 2% of the inches per hour absorption rate in the test holes. The absorption rate may decrease 20% in 16 months; more rapidly if ground garbage is discharged into the tank. Ordinarily tanks should be cleaned about every four years but a garbage grinder may increase the rate of sludge and scum accumulation by 50%. Yeast has no merit as a "starter" and the various proprietary compounds purported to "condition," "start," or "clean" tanks may do more harm than good.

Miles Lamb (56) has discussed the design of small activated sludge plants and presented curves showing aeration periods, air requirements for various strengths of sewage, and the most economical tank dimensions.

The FSIWA Sewage Works Practice Committee issued in 1952 its manual of practice No. 5, "Air Diffusion in Sewage Works" (57). This manual was prepared by a sub-committee headed by Norval E. Anderson, M. ASCE, and con-

tains much basic information for the design of air diffuser systems, and for their operation and maintenance. Mechanical aerators for small plants are also covered. The manual contains extended reference to taste made by The Sanitary District of Chicago and others, as well as operating experience. However, it omits the important topic of specifications for buying new diffuser plates and the important tests to be made in inspecting and checking the plates.

A recent experience of The Sanitary District of Chicago is of interest in purchasing 31,800 diffuser plates to replace plates at the North Side Treatment Works which had been in successful use for over twenty years without serious clogging. The original installation consisted of two rows per channel of plates originally rated at a permeability of 12 to 15. The new plates were specified to be of a permeability of 80, with one row in each channel to replace the two as originally built. During the first year of operation with the new plates, the operating records show that 0.68 cu. ft. of air per gal. of sewage was used instead of 0.44 cu. ft. per gal. as a 10-year average from 1941 to 1950, and the use of electric power by the blowers rose from an annual average of 19 million KW per year for the years 1941 to 1950 to a new high of 32 million KW per year, with a resulting increase in the cost of power of approximately $102,000 per year. The inspector reported that the plates tested as specified at 80 permeability but subsequent investigation revealed that the plates were actually equivalent to a 120 permeability. The manufacturer then admitted that he thought he was doing the purchaser a service in making his plates of a coarser mixture than heretofore, which might postpone clogging.

In the meantime, tests by the Sanitary District over a period of several years indicated that the permeability test alone is not an adequate measure of air diffusing efficiency, and that a supplementary oxygen absorption rating may be necessary. A wide range of oxygen absorption is possible with plates of equal permeability.

The oxygen absorption test suggested is based on diffusing air at a selected rate through a diffuser suspended in sodium sulfite solution with a depth of 3 ft. over the diffuser. Further investigations are being made to determine the reliability of such a test and what to specify. This work has been described by H. R. King, M. ASCE, (96).

A. A. Kalinske, M. ASCE, and H. W. Gillard have discussed the new developments in biosorption, step-aeration, and short-period activated sludge (58).

R. S. Rankin, M. ASCE, has discussed basic design consideration for trickling filters (59). Geo. J. Schroepfer, M. ASCE, has discussed trickling filter media (60) with respect to the effect of particle shape on porosity and surface area.

Pumps

R. Carter and I. J. Karassik have published a series of articles (61) dealing with the basic considerations in the application, selection, and operation of centrifugal pumps. This is a series of 9 articles appearing over the past two years and covers the subject of centrifugal pumps quite thoroughly.

A new "bladeless" trash pump has been introduced by Fairbanks-Morse and Company which may serve in small sewage pumping stations (62) to avoid stoppages due to rags and other trash. The first real solution to pumping water containing trash was provided by Mr. A. B. Wood about 1915 for the New Orleans Sewerage and Water Board. In 1925 the right to manufacture and sell the patented Wood Trash Pump was acquired by Fairbanks-Morse and Company. When the basic patents on the Wood trash pump expired, other manu-

facturers entered the field. Practically all were modifications of the Wood design with minor variations from the original blade form. For the smaller pumps, however, because of the thick blade cross-section of the Wood pump vane, this pump did not have a high degree of efficiency. The new bladeless pump has a single-channel circular-section impeller without blades, the pumping action being obtained by so twisting the channel as to produce the equivalent of one flow section of a conventional impeller. This pump is manufactured in sizes from 2 in. to 5 in. and has about 10 times the non-clog characteristics of a conventional pump but only about half the capacity. The Detroit sewage plant has been experimenting with the bladeless impeller pump on raw primary sludge. One such pump installed in 1950 has performed satisfactorily and two more of the same type have been ordered (63).

Tentative Standards for Sewage Works

Tentative standards for the design of sewer systems and sewage treatment plants (mentioned in the last report of this Committee) have been adopted by the Upper Mississippi River and Great Lakes Boards of Public Health Engineers (64), and are used by the State Boards of Health in that region as a guide for determining the adequacy of plans for sewers and sewage treatment works, submitted for approval.

Aerated Grit Chambers

Little additional information on air grit chambers has been published during 1952. The use of air diffusers for grit separation as first installed in Columbus several years ago has apparently been satisfactory (65). So far as can be learned, air grit separation is in use in five or six plants in the United States and is being installed in at least six more.

Ventilation of Sewage Plants

K. E. Robinson emphasizes the need for adequate ventilation in the design of sewage treatment works (66) from the viewpoint of safety. The new Owls Head plant in New York City (30) is an example of extensive ventilation provisions from the standpoint of odor control.

Plastic Lining for Sewers

Protecting concrete against the deteriorating action of sewer gases containing hydrogen sulfide has been a troublesome problem in Southern California. The long, flat sewer lines in this vast decentralized area, combined with a warm climate, are conducive to the formation of hydrogen sulfide which is corrosive to concrete. An interesting attempt to combat this corrosion has been made (67) in Orange County where over seven miles of concrete sewer pipe ranging in size from 39 to 78-inch have been lined with sheet plastic 0.06-inch thick. Sheets of vinyl plastic approximately 4 x 8-ft. in size were softened and welded into one continuous lining by a hot-air torch. Only the top 2/3 to 3/4 of the pipe was lined. The invert was not lined because only that portion of the pipe above the flow line is exposed to the corrosive gases. The cost of the lined pipe at trench side ranged from $16.80 per foot for the 39-inch pipe to $40.40 per foot for the 78-inch pipe.

Hydraulics of Sewers

T. R. Camp, M. ASCE, has published (89) a paper on the design of sewers, incorporating the latest information on the roughness factor "n" as used in the Manning equation for velocity and on the determination of the minimum slope required for self-cleansing of sewers.

PLANT OPERATION

Screenings and Grit Disposal

S. L. Tolman, M. ASCE, (68) has discussed current practice in the removal and disposal of screenings and grit. Except for the smaller plants, the back-rake type of bar screen is now preferred because of less jamming of the rakes. The design and operation of screens, grinders, comminuters, grit channels, and grit washers are covered.

Re-Use of Plant Effluents

In a few instances where water supplies are scant or expensive to treat, sewage plant effluents are being used for industrial water supplies. The Bethlehem Steel Company is now using an average of 46 mgd of plant effluent from the Baltimore Back-River sewage treatment plant (69). This quantity of effluent receives further treatment in a company-owned waterworks located at the sewage plant. It is expected that the Steel Company will eventually take the entire effluent, expected to reach 155 mgd by 1965. Troubled with salt water intrusion into 32 artesian wells, the company turned to purchase of sewage plant effluent. A 20-year agreement set up in 1942 provides payment by the Company to the city of $1,000 per month for flows up to 25 mgd, $1,500 per month for 25 to 37.5 mgd, and $2,000 per month for 37.5 to 50 mgd. For an additional charge of $150 per month, the city disposes of sludge from the industry's water works. In return for this payment, Baltimore permitted the construction and operation of the industrial water works on city property. The sewage disposal plant uses two treatment methods: activated sludge, 20 mgd capacity; and trickling filters, 239 mgd capacity. The effluent from the activated sludge process is low enough in suspended solids (25 ppm) to require only chlorination by the industry. The trickling filter effluent which averages under 50 ppm suspended solids is flash-mixed with coagulant, flocculated, settled, screened, and chlorinated in the industrial water works, which delivers the treated water through a seven-mile pipe line to a reservoir at the steel plant.

Ventura, California has entered into an agreement with the Shell Oil Company for the use of plant effluent (about 1 mgd) now flowing from the Ventura sewage system into the ocean (70). The city will lease to the oil company sufficient land adjacent to the present primary treatment sewage plant for the construction of facilities for further treatment of the effluent. At the expiration of a 20-year lease, the city is to receive title to the water treatment plant, after which the treated effluent will be sold to the industrial users.

Indirect re-use of sewage -- spreading it to replenish ground water supplies -- has been studied at the University of California (71). No satisfactory basis for the design of sewage plant effluent spreading areas has as yet been determined. Pilot scale studies have been started on the use of field spreading basins in different soils.

Effect of Detergents

The troublesome effects of detergents on sewage plant operation has continued to receive much attention, principally in regard to frothing on aeration tanks. New York City reports (27) that the suds have reached a maximum depth of nine feet on the aeration tanks, creating a hazard to the attendants by leaving a greasy coat on the walks and other structures. The froth is also destructive to grass and shrubbery adjacent to the tanks. New York has made field tests at several of its plants with various chemical "defoamants" and

with water sprays. They report that a combination of these two remedies seems to present a satisfactory solution and installations along these lines are being made. Los Angeles has also reached a similar conclusion and has installed water sprays. Both cities concluded that the use of detergents may be the cause of high air consumption.

Baltimore determined the detergent content of the raw untreated sewage at the Back-River plant (72). Based on a short series of analyses over a five-day period, a reduction of detergent content in passing through the treatment processes was indicated: The removal of detergents by primary settling being about 14%; by primary settling, trickling filters, and secondary settling about 39%; and by primary settling plus activated sludge treatment, about 21%. It was concluded that the detergent content at Baltimore was so small as to have no apparent detrimental effect on the treatment processes except for the nuisance caused by the formation of froth.

R. W. Simpson (73) points out some of the available evidence in the controversy as to whether or not detergents have a detrimental affect on the efficiency of sewage sedimentation, and concludes that this point is still questionable although detergents tend to emulsify grease, resulting in more grease being carried over into secondary treatment processes. From laboratory tests, it was indicated that froth production in sewage is dependent upon length of aeration and concentration of detergent. He reports on tests of various defrothing agents.

R. Eliassen, M. ASCE, has discussed the basic principles of detergency (74). The sale of synthetic detergents in the past twenty years has climbed from nothing to about one billion pounds in 1950, rapidly approaching the consumption of solid soap which has been in use for 2,000 years and which was consumed at the rate of 2.3 billion pounds in 1950. Soap is a detergent resulting from the reaction between animal and vegetable fats and caustic soda. The anionic type of synthetic detergent is the most commonly used and is usually a sodium alkyl sulfate. The chemical and physical properties of detergents are discussed. As detergents have the ability to keep dirt in a state of suspension, Eliassen concludes that sedimentation efficiency in sewage plants will be reduced by their presence, and that a program of research is needed to develop satisfactory economical methods of overcoming the detergent effects.

W. B. Stevens considers the use of foam control agents effective (75), claiming that certain of these agents are economical at concentrations of about 1 ppm.

"Sewage and Industrial Wastes" (75) has adopted the term "froth" in referring to the aeration tank problem as distinguished from the "foam" problem at sludge digestion units, to preclude confusion in terminology.

In starting up the new Northeast plant in Philadelphia, R. A. Hoot (34) had trouble with frothing of the aeration units. Various defoamants were found effective but too expensive for regular use. The froth was found to possess a high content of coliforms and total bacteria. New York City found the froth to be about 1/3 to 1/2 grease (27).

R. Manganelli has also discussed the effects of detergents (76). He reported that synthetic detergent production has increased from about 28 million pounds in 1941 to 1.5 billion pounds at the present time. In the same period, detergent sales have increased from 1% to 54% of soap sales. Anionic detergents account for about 90% of the total and of this over 40% is of the alkyl sulfanate type. Laboratory studies indicated that the anionic type had no affect on sewage oxidation processes. The cationic type did have some effect on these processes and in general it was concluded that some decrease of aeration efficiency may

be expected to result from the growing use of detergents. There may be also some decrease in gas production and increase in coagulant dosage requirements. Deleterious effects of detergents on sewage treatment and sludge digestion have been indicated by W. A. Sperry at Aurora, Illinois (97) where the sewage contained 45 ppm of detergents.

At San Antonio, Texas, W. N. Wells and C. H. Scherer (77) claimed success in controlling the quantity of froth present on the activated sludge plant aeration tanks by varying the amount of suspended solids in the mixed liquor. Frothing was kept under control by maintaining the solids above 1,400 ppm, although the plant is operated at 2,000 to 3,000 ppm as a margin of safety. Similar results were obtained at Cranston, R. I. where operation at the 3,000 to 3,500 ppm solids level renders the plant free of froth trouble (78).

At the works of The Sanitary District of Chicago, L. Pearse, M. ASCE, reports that foaming has occurred on the aeration tanks but apparently has not effected the efficiency of the treatment. The increase in use of detergents is believed to account for an increase in phosphate in the heat-dried activated sludge at both the Calumet and Southwest Works since 1948, as shown in the following tabulation:

The Sanitary District of Chicago

Heat-Dried Activated Sludge
Phosphoric Acid (APA)
Per Cent of Dry Solids

Period	Southwest	Calumet
January, 1949	2.432	2.853
Average, 1949	3.100	3.33
Average, 1950	3.463	3.393
Average, 1951	3.740	3.646
Jan.-June, 1952	3.492	3.874

Chemical Treatment of Sewage

Very little additional information has appeared in 1952 on the chemical treatment of sewage. It is used as a short-period supplement to primary treatment at the Wooster, Ohio, 6 mgd sewage plant (79). Whenever the dissolved oxygen content of the receiving stream drops below 5 ppm at the plant, chemical treatment is started to keep the stream above the minimum of 4 ppm D.O. as established by the Ohio Department of Health. Ferric chloride and lime are used at dosages of approximately 17 ppm and 170 ppm, respectively. The number of days out of the year that chemicals were used has varied from none at all in 1943, 1947, 1948, and 1950 to 71 in 1951. The plant was placed in operation in 1939. With primary sedimentation only, removals between 60 and 69% of the suspended solids and between 30 and 44% of the B.O.D. are obtained. With chemicals, a total reduction of approximately 83% of the suspended solids and 62% of the B.O.D. is obtained.

The Guggenheim process has not appeared in any recent installation so far as the Committee knows. The East Chicago, Ind. plant is still operating as heretofore. The New Britain, Conn. (9 mgd) plant is still operating under a considerable overload (at 11 mgd or more). J. R. Syzmanski (98) has reviewed the history of sewage treatment at New Britain where the sewage contains large amounts of waste pickling liquor, sometimes as high as 400 ppm of Fe during periods varying from 5 min. to 8 hrs. The operating data given indicate that since 1949 the aeration period has averaged 1.2 hr. with the use of

0.11 cu. ft. of air per m.g. The amount of copperas added to the raw sewage has varied from 81 to 114 lb. per m.g. and chlorine from 18.3 to 22.6 lb. per m.g. Occasionally ferric sulfate is added. The final effluent on 12-month periods has averaged 52 ppm B.O.D. (72% reduction) and 42 ppm suspended solids (79% reduction), and contains 7 to 8 ppm of Fe. The volume of return sludge in per cent of raw sewage volume has varied from 8.8 to 10.6. In conditioning excess sludge, ferric chloride and wet prestolime are used. The filter cake contains about 30% solids.

Trickling Filters

F. L. Flood has briefly reviewed (81) the usage of high-rate filters in this country and especially in the New England States. Five high-rate filter plants in New England were designed for loadings ranging between 1660 and 2580 pounds of 5-day B.O.D. per acre foot per day, and for flow rates ranging from 8.9 to 14.3 m.g.a.d., all based upon the use of single-stage filters with six-foot depth of stone. Operating results from five New England high-rate trickling filter plants for the years 1950-1951 indicate an average over-all removal of about 85% of the suspended solids and 5-day B.O.D. The author states that high-rate filters are in competition with high-rate activated sludge plants on new installations for all but the very large plants. The advantages and disadvantages of high and low-rate filters and activated sludge were discussed briefly. In the author's opinion, where the high-rate filter is suited to the local conditions, it is usually the preferable treatment process because it is simpler to operate, less subject to process upsets, and the operating costs are usually lower.

An unpublished report (82) by the U. S. Public Health Service, contains the result of a study made at Webster City, Iowa of the comparative efficiency of two high-rate filters, one recirculating plant effluent to the filter influent and the other recirculating filter effluent to the filter influent. The two filters and their respective settling tanks were identical in size, with a recirculating ratio of 1 to 1 for both filters. Including recirculation, the loads on the filters averaged 21 m.g.a.d. and 1.¼ pounds of 5-day B.O.D. per cu. yd. of stone. The report concluded that: (1) With direct recirculation of the filter effluent, there was less tendency toward ponding, and B.O.D. removals were equal to or slightly greater than with recirculation of the final effluent; (2) Slightly greater nitrification was also produced; (3) about 70% removal of the B.O.D. was obtained, producing an effluent with about 40 ppm B.O.D. (from normal community sewage).

The results obtained at Baltimore (49) by converting the original low-rate filters into high-rate filters has previously been discussed in this report under the section "Enlargements of Existing Plants".

One of the biggest problems in trickling filter operation is the control of psychoda flies. Efforts to control these filter flies by the use of insecticides at the Akron, Ohio plant have been reported by T. C. Schaetzle (83). From 1929 to 1947, filter flies were the partial cause of $130,000 damage suits against the city. After several years of testing, Mr. Schaetzle concluded: (1) That the flies are effectively destroyed by benzine hexachloride containing11% gamma isomers applied at a rate of 4.5 gal. per acre; (2) The first application should be made early in the season at double the above rate; (3) A two-hour period of contact is required, produced by resting the filters after application of the chemical; (4) The use of insecticide is better than flooding because the latter procedure causes unloading of the beds, requires more time, and is less effective as a fly killer; (5) Rotation of insecticides is advisable to prevent de-

velopment of fly immunity to any one chemical.

Activated Sludge

Most of the recent literature on activated sludge is concerned with the so-called high-rate or short period modifications of the original process. Biosorption -- a process applied so far only at Austin, Texas -- was developed simultaneously by two groups working unknown to each other 1300 miles apart during the past 2-1/2 years -- A. H. Ullrich and M. W. Smith at the Austin sewage plant, and J. Hood with W. Eckenfelder at Ridgewood, New Jersey (84). Ullrich and Smith worked out the process in connection with efforts to relieve the overloaded plant at Austin (85). Biosorption is a high-rate biological treatment process in three steps: (1) Raw sewage is mixed briefly with activated sludge. (2) The mixed liquor goes to a settling tank, the effluent of which is the plant effluent. (3) The settled sludge goes to an aeration compartment for aerobic digestion and reactivation prior to recirculation. Austin's sewage (8.5 mgd) has been treated by the above process for over a year. The raw sewage B.O.D. of 200 to 250 ppm is reduced to 10 to 25 ppm using 0.75 to 1.0 cu. ft. of air per gal. of sewage, with 0.5 hr. mixing, 2.5 hr. settling, and 2.5 hr. aeration, (on a sewage flow basis). Advantages claimed are: smaller aeration tanks, no primary sedimentation tanks, and a more stable process under shock loads.

The biosorption process has also been discussed by Kalinske and Gillard (58). Only carbonaceous oxidation occurs in this process because of the short retention time. At Austin, the returned sludge based on average sewage flow was 35 to 40%. It is claimed that the biosorption process will give results comparable to conventional activated sludge treatment in considerably smaller structures. Kalinske and Gillard also review developments in modified-aeration at New York City where results ranging from 65 to 80% removal of the B.O.D. (sufficient for the local conditions) have been obtained in much smaller plants than would be required for the conventional activated sludge process.

The "modified sewage aeration" process as developed at New York City (30) has already been mentioned in this report under "Sewage Treatment Projects." In this process the primary settling tank may be eliminated. From the screen and grit chambers the sewage proceeds at once to the aeration tanks. After aeration for a relatively short period of about two hours, with returned sludge, the sewage passes to the settling tanks having a retention period of 1.5 to 1.7 hours. The settling tank effluent is the plant effluent. Part of the sludge from the settling tanks is returned to the aeration tanks, while the balance goes to the digesters. This process is expected to remove 75 to 80% of the suspended solids and B.O.D. from a raw sewage containing 200 to 225 ppm.

SLUDGE DISPOSAL

Sludge Digestion

H. A. Schlenz, A.M. ASCE, (86) has discussed basic principles of design and operation of sludge digestion equipment. The control of temperature pH, volatile acids, scum, foaming, and supernatant are discussed. Mr. Schlenz believes that more careful control of the digestion system on the part of operating personnel at sewage treatment plants in general would eventually make it possible to effect a reduction in present digestion capacity requirements established by State Boards of Health, and that this would reduce appreciably the cost of digestion installations and the operating cost per lb. of solids handled.

L. W. Van Kleeck, M. ASCE, (87) has discussed the control of sludge quality in unheated and heated digestion tanks, from both the design and operating view points. Other sludge control factors were discussed in three previous articles by the same author.

The effect of garbage on sludge digestion was reviewed by T. R. Haseltine, M. ASCE, (88). Attempts to digest garbage alone produced acid conditions at a pH too low to permit digestion. Digestion with sewage sludge was successful in ratios of 1.5 to 3 garbage to one sludge. Operating methods and results on digesters containing garbage and sewage sludge were described.

Sewage sludge gas, its compression and storage, is discussed by E. C. Powers in a series of articles (99).

Sludge Elutriation

Development work on interstage elutriation has continued. A. L. Genter, M. ASCE, reports it is being used at the San Francisco sewage treatment plants and at Baden-Baden, Germany. Other new plants such as those at Tacoma, Washington; Wilmington, Delaware; Sacramento and Los Angeles, California will be equipped to use this process. It involves use of elutriation between the active and inactive stages of digestion to save digestion space and to improve plant operation as well as sludge quality. Final counter-current elutriation is also used after the final stage of digestion to reduce sludge alkalinities and save coagulant chemicals.

In New York City, development work was done at the Jamaica plant by W. N. Torpey and M. Lang on the use of elutriation as a substitute for secondary digestion (90). In 1950 the solids content of the digested sludge had dropped to such low concentrations as to require barging to sea of excessive volumes of sludge. A method of concentrating the digested sludge solids was needed. High-level digester liquor averaging 2 to 3% solids was concentrated in a single stage elutriator. The elutriated sludge contained 3.9 to 7.4% solids. A single-stage elutriation tank was found to be as effective in concentrating the digested sludge solids as a secondary digester with 12 times the volume. Substitution of elutriation for secondary digestion would result in a reduction of only 10% in gas production, as the major contribution of secondary digestion is the concentration of sludge solids with consequent reduction of sludge volume. New York is continuing this investigation in the hope of reducing investment in digestion tanks and in the volume of sludge to be disposed of.

Sludge Concentration

The main difficulties encountered in disposal of activated sludge are caused by the voluminous and flocculant nature of the sludge. Decreasing the volume of waste activated sludge is desirable before continuing further treatment. Seven years experience with activated sludge concentration at Cleveland has been described by J. J. Wirtz, F. J. Ausflug, and C. E. Kirsch (91). Concentration of waste activated sludge by the "picket-fence" type thickener requires 6 to 12 hours and difficulties may be experienced with decomposition of the sludge. The Cleveland Easterly plant has found it more satisfactory and economical to concentrate the mixed liquor, rather than the waste activated sludge, by plain settling in two of the final clarifiers. The concentration tank overflow approaches the quality of typical plant effluent, with suspended solids less than 30 ppm. The concentration of mixed liquor in an environment of dissolved oxygen or nitrate will produce a thickened sludge containing about 30,000 ppm total solids. Odor nuisance is eliminated. An over-flow rate of 400 g.p.d. / sq. ft. is used for a control of the clarifiers converted to concentration tanks,

compared with a normal over-flow rate in the final settling tanks of 800 g.p.d. / sq. ft.

The Laboon process of raw sludge concentration by flotation in heated tanks is proposed for the Pittsburgh sewage treatment plant (92). The design basis at Pittsburgh has already been discussed in this report under "Sewage Treatment Projects," p. 13. In this process, the sludge is held for five days at 95° F. The CO_2 gas produced causes the solids to float. The subnatant liquor may be drawn off and the sludge remaining has a concentration of about 20%. Development work so far has been on a laboratory and pilot plant scale. Inert matter, excepting unusually high concentrations of silt and grit, has no observable effect on the flotation process. Apparently the process does not function well with activated sludge. Estimated annual charges for sludge disposal at Pittsburgh by incineration of concentrated raw sludge without vacuum filtration are $100,000 less than the cost with vacuum filtration; or with digestion, elutriation, filtration, and incineration.

Sludge Utilization

Milwaukee, The Sanitary District of Chicago, and Houston are now selling heat-dried activated sludge for fertilizer. Los Angeles has recently begun selling heat-dried digested short-period aeration sludge, and is now installing pelletizing equipment to bring the dried sludge to a more desirable physical condition for marketing. Baltimore, Md. expects to complete its heat-drying plant in the fall of 1952, handling digested activated sludge.

Milwaukee is selling all its heat-dried activated sludge in bags to an established line of jobbers, with a guaranteed analysis of 6% nitrogen.

Chicago is selling all its heat-dried activated sludge to an exclusive contractor on a two-year contract in bulk carload lots on the basis of analysis, as stated in the last report of this Committee. The contract price of $2.50 per unit of Ammonia and $0.36 per unit of available phosphoric acid (APA) is subject to adjustment according to a price index. The current price paid Chicago for the Southwest sludge is about $18.00 per ton. The material is dried to a moisture content under 5%. At Houston, Texas the heat-dried sludge is sold in bulk carload lots on the basis of $2.59 per unit of Ammonia and 40¢ per unit of APA, totalling $12.37 per ton.

Experience is needed to determine the difference in Ammonia content in a sludge from a short-period activated sludge and the conventional type of activated sludge such as Milwaukee and Chicago produce. There is also lack of commercial data to, indicate the demand for the lower grade sludge when heat-dried and the price which can be obtained.

L. R. Howson (15) has questioned the economics of fertilizer production for most sewage treatment plants. He stated that while the sludge has some value as a soil builder, in the majority of cases any revenues therefrom can only be secured by expenditures materially in excess of the revenues. There appears to be a scarcity of data in the literature affording proof of the economy of fertilizer production from sludge by heat-drying, as compared with disposal by incineration.

C. E. Keefer, M. ASCE, has reviewed sludge disposal and utilization experience at Baltimore (93) ranging from drying beds, to vacuum filters, to the $2 million heat-drying plant now under construction.

Sludge disposal and utilization experience at Battle Creek, Michigan has been described by R. R. McIntosh (94). From 1936 to 1944 the sludge from the primary sedimentation and separate sludge digestion plant for this city of 50,000 inhabitants was air-dried on drying beds. In 1944, vacuum filters

and a flash-drier were installed. A dried fertilizer was produced under the name of "Battle Creek Plant Food" which was sold from 1944 to 1950 at a small profit. Increased freight rates and labor costs together with the construction of more sewage plants producing fertilizer, limited the sale of the product almost entirely to local consumption and the plant began to show a loss on fertilizer production. The city then accepted the offer of a local industry for the leasing of the sewage plant fertilizer equipment to be used for drying a gray, mud-like waste proudct produced in the manufacture of penicillin. The dried product is used in animal feeds. Digester gas is sold to the industry as fuel for the drier and is expected to bring greater financial returns to the city than formerly received from the sale of fertilizer. The sewage sludge filter cake is now returned to the original sludge drying beds and the cost of the removal from these beds is paid by the industry which leased the drier plant.

Vitamin B_{12} in Sludge

The announcement during 1950 of the discovery of Vitamin B_{12} in sewage sludge aroused considerable interest (1) (p.566). The vitamin was isolated during biological oxidation tests on dairy wastes by the U. S. Department of Agriculture. Later its presence was determined in activated sludge at various municipal plants, including Milwaukee and Chicago. Considerable research has been carried on at Milwaukee to determine an economical method of extraction of B_{12}. At Chicago, a project is underway with the cooperation of the University of Illinois to determine the effectiveness of heat-dried activated sludge as an ingredient in animal food.

S. R. Hoover, L. Jasewicz, J. B. Pepinsky, and N. Porges (100) report that activated sludge contains significant amounts of Vitamin B_{12}; dried commercial fertilizer contains approximately 3.5 to 4 mg per kg. This amount is comparable with that required in commercial animal feed supplements (3.3 mg per kg). Apparently part of this vitamin is derived from the raw sewage and part synthesized by microbiological action in the aeration tanks.

However, at present the animal protein factor supplement can be produced by direct bacterial fermentation using aerobic cultures and highly aerobic conditions, whereby Vitamin B_{12} is developed (101).

Vitamins have concluded a banner year with new and improved processes and widening uses bringing lower prices (102). The biggest changes in 1951 included a surge in Vitamin B_{12} for human nutrition, and surpassing this growth, its use, under the name APF, in feed additives for live stock. During 1951, the price of B_{12} dropped from $595 to $350 a gram ($159,000 per lb.). Improvements in technology and widening uses point to still lower prices later.

A new extraction technique (103) has been developed by the Miner Laboratories, Chicago, Ill. for the Milwaukee Sewerage Commission, which is now in the pilot plant stage. At present, the process is capable of extracting up to 50 milligrams of the vitamin from each pound of heat-dried activated sludge produced, without reducing the value or volume of the sludge as fertilizer. B. Wolnak states (103) that the form of B_{12} suitable for human beings now is priced at about $159,000 per lb., whereas a less concentrated form used for animal feeding is $27,000 per lb. Both forms are in short supply.

Sludge Lagoons

Lagooning of sludge is still being practiced to some extent. Houston has a new sludge fertilizer plant but the old lagoons continue in use for peak sludge loads. Indianapolis (46) which has always used sludge lagoons for disposal of

its excess activated sludge recently purchased 200 additional acres of land for this purpose.

Chicago has used sludge lagoons for a number of years as a temporary measure. Some odor troubles have been experienced which might be avoided by heat-digesting the sludge for 15 or 20 days before lagooning (134). •

The new Northeast plant at Philadelphia (34) is using lagoons temporarily for disposal of the digested sludge with an estimated lagoon capacity sufficient for eight years of operation, comprising 4 lagoons 8 to 10 ft. deep ranging from 7 to 17 acres in area with a total capacity of 900,000 cu. yds.

Winnipeg (95) is experimenting with the use of sludge lagoons because of the increasingly high cost of sludge disposal by other methods. At present the digested sludge is filtered on vacuum filters and the filter cake is hauled by dump-car out on a trestle to a storage yard with 6,000 cu. yds. capacity. Landscape and market gardeners and the Park Board are encouraged to use this sludge without charge, but such usage has not been sufficient to dispose of all the sludge cake produced so the remainder is removed by contract. Due to the location of Winnipeg, the coagulant chemical (ferric chloride) must be shipped in from distant sources. With increased prices and freight rates, the cost of ferric chloride has increased from $86 per ton in 1940 to $160 per ton in 1951. At the dosages required, the cost of ferric chloride per ton of dry sludge solids filtered increased from $2.65 in 1940 to $6.72 in 1951. In addition, the cost of removing the sludge from under the dumping trestle has also increased. Altogether, the cost of elutriating, filtering, and removing the sludge had risen from $13.80 per ton (dry weight) in 1944 to $23.10 in 1949. Faced with these rising costs and the need for expanding the plant, Winnipeg resorted to sludge lagooning and awarded a contract in 1950 for the construction of six test lagoons and two drying beds. Each of the test lagoons are 100 x 150 ft. in area; three are provided with underdrains; each of the two drying beds are 50 x 150 ft. Because of the impermeable characteristics of the local clay soil, some underdrained lagoons are included. The lagoons are being used through 1951 and 1952 to determine their feasibility under the local conditions.

Dual Disposal of Garbage With Sewage

The dual disposal of garbage with sewage was discussed at length in the last report of this Committee (Oct. 1951). A recent review by this Committee indicates that a number of cities still prohibit the use of garbage grinders. There is a dearth of accurate information on the actual number of kitchen grinders installed and the effect on sewage treatment works. The National Electrical Manufacturer's Association marketing records indicate that the total number of grinders installed in the United States is over 1,000,000. From information received, the following notes on the number of grinders installed in several cities as of 1951 may be of interest:

Number of Kitchen Garbage Grinders as of 1951

City	Census Population in 1950	Number of Dwellings	Number of Grinders, 1951	Per cent of Dwellings
Cincinnati	503,998		1,500	
Detroit	1,849,568		14,500	
Suburban			8,000	
Los Angeles - City		750,000	50,000	6.7
County	1,970,358	1,200,000	150,000	11.5

Milwaukee -				
City	637,392	189,214	2,200	1.2
County		57,992	2,000	3.5
Portland, Ore.	373,628		850	
Newton, Mass.	81,994		1,800	
Rochester, N. Y.	332,488		3,350	
San Diego	334,387		2,000	
San Francisco	775,357		2,000	
Schenectady	91,785		1,000	
Springfield, Mass.	162,399		131	
St. Paul, Minn.	311,349		4,500	

Many cities report that no record is kept. The general attitude seems to be that the cost of the grinder and its installation will retard its introduction. The smaller cities are more apprehensive of overloading the sewage treatment works than the larger.

R. W. Simpson (104) has discussed the effect of ground garbage on sewers and sewage treatment. He anticipates some troubles in flat grade sewers, pump wells, and siphons. More grit will be obtained and require better washing. Raw sludge will increase by about 50%.

B. A. Poole, M. ASCE, and G. K. Erganian, A. M. ASCE, have pointed out the public health benefits from the disposal of garbage in sewers (105), and reviewed the garbage grinding project at Jasper, Ind. The U.S. Public Health Service and the Indiana State Board of Health have started a study on the effect of the mass installation of these grinders on the general sanitation level of the community. Some sanitary problems were created and strict enforcement of local ordinances is necessary. No adverse effect of ground garbage on the sewer system or treatment plant has been indicated.

Composting of garbage with other refuse, manure, or sewage sludge has been receiving some attention recently, particularly in California (106). Composted material at Oakland was sold for about $34 per ton. No analyses or production costs have been published. Special bacterial cultures were used for decomposing and stabilizing the material at Oakland, although H. B. Gotaas, M. ASCE, reports that no special cultures were necessary in composting work done at the University of California, the garbage containing all the bacteria necessary. More experience and data are necessary to determine whether composting of municipal organic refuse for use as fertilizer can be economically justified.

INDUSTRIAL WASTES

During the past two years, interest in the treatment of industrial wastes has continued to expand. Annual industrial waste conferences continue to be held at Purdue University in Lafayette, Ind. At various State conferences, industrial waste problems are prominent on the program. Industry has picked up the challenge and is planning its flow sheets to reduce the waste to a minimum.

In the literature on industrial wastes in the past two years, the annual review by the Committee on Research of the Federation of Sewage and Industrial Wastes Associations (1) and the Symposium of the American Chemical Society (107) are outstanding.

In the ACS symposium, a comprehensive program was presented on the nature and present status of liquid wastes disposal problems in representative

industries in the United States including antibiotics, atomic energy, citrus fruits, corn products, dairy industry, grain distilleries, organic chemicals, packinghouses, petroleum refineries, pulp and paper, steel, tanneries, brass and copper, waste disposal in Great Britain, removal of color in wastes, sulfuric acid recovery from waste liquors, wastes containing radio-active isotopes, mechanism of methane fermentation. As these papers are available as a reprint, this Committee does not attempt to review them.

In an article on the Disposal of Industrial Waste Waters in the United States (108), F. W. Mohlman presents a concise review of the industrial waste situation, with many references to experience in The Sanitary District of Chicago.

B. A. Southgate offers a review of the disposal of Industrial Waste Waters in Great Britain (109) commenting on the general practice of pretreatment of wastes before discharge into municipal sewers, the re-use of waste waters, and the disposal of gas liquor.

Two new books which may be of interest to the student of industrial wastes have appeared in 1951-1952, written by Charles H. Lipsett (110) and E. B. Besselievre, M. ASCE (111).

Another useful reference book for those interested in industrial wastes is composed of a series of articles describing chemical manufacturing plants by the editors of Industrial and Engineering Chemistry (112). The articles are reprinted from the Journal plant-process articles. A new volume is to be issued every other year.

Among the various papers on Industrial Wastes which have appeared, the following are noted:

According to H.H. Black, M. ASCE, and G. N. McDermott, Jun. M. ASCE, (113) in 1948 beet sugar was produced in 85 plants operating in 16 states, with a total tonnage of 1,369,000 tons of beet sugar from 9,422,000 tons of beets. The liquid wastes from the industry are estimated to be equivalent to 17,000,000 population. Operation is seasonal. Various remedial measures are suggested including elimination of pulp screen water, segregation and re-use of waste water, and by-products recovery.

T. R. Haseltine (114) describes a study on kraut and pickle wastes containing over 1,000 ppm B.O.D. which indicated that chloride concentrations up to 5,000 or 6,000 ppm have little or no effect on the biological efficiency of a filter, and that there was no correlation between the recycle ration and the B.O.D. reduction. During a period of 109 days of operation, about 252 gal. of sludge were produced containing 81 lb. of total solids or 47 lb. of volatile solids per 1,000 lb. of B.O.D. removed. The sludge dried rapidly on open-air beds.

Waste savings accomplished by American Maize Products Company are described by E. M. Van Patten and G. H. McIntosh (115) who state that formerly waste waters approaching 15 mgd and a population equivalent of 3,500,000 were discharged without treatment into Lake Michigan. As a result of a comprehensive study of its wastes and process operations, a decision was made to alter processes and equipment to eliminate rather than to treat. The program involved: (a) reduction of solids entrainment; (b) isolation of condensates from cooling waters; (c) concentration of filtrates and wash waters by evaporation; (d) elimination of excess wash and filtrates water; (e) eliminate sewering of pan boil-out waters; (f) recasting of equipment; (g) replacing equipment; (h) permanent addition of chemists to supervise and study wastes; (i) automatic sampling; (j) metering all wastes; (k) sterilization of waste water sent to lake; (l) altering processes used in production. The cost has been $850,000 over seven years. About 92% of the pollution has been

eliminated with population equivalent reduced to 28,000 and with further reduction planned. A 1% increase in overall plant yields was obtained, resulting in $175,000 return annually. A better control of all processes was secured.

The disposal of antibiotics wastes from the manufacture of penicillin and streptomycin at the Upjohn plant at Kalamazoo, Mich., was investigated by E. Hurwitz, K. H. Edmondson, and S.M. Clarke, M. ASCE, (116) who found that such wastes can be successfully treated on trickling filters at reasonable loading and with high percentage removal.

W. W. Mathews (117) has shown on a plant operating scale at Gary, Ind. that the treatment of ammonia still wastes (containing up to 12.3 ppm of phenol in terms of sewage flow) by the activated sludge process is practicable. He concludes that: (1) Phenol in the ammonia still wastes, in terms of sewage flow, could be treated in concentrations up to 25 ppm with approximately 100% effectiveness; (2) Solids concentration in the mixed liquor must be increased to take care of the increased load; (3) Extra air must be supplied because of the additional organic load imposed on the treatment process; (4) A higher rate of sludge return is required if air requirements are to be kept to a minimum; (5) Complete destruction of phenol cannot be effected with the aeration period greatly reduced.

D. E. Bloodgood, A.M. ASCE, (118) reviews the history of the investigation of strawboard wastes and the treatment thereof and suggests that for many situations well-operated lagoons are satisfactory.

By-Products From Industrial Wastes

A. P. Troemper (119) states that in Illinois the major developments in waste treatment and recovery are in the distilling, paper, canning, and coal mining industries. In the distilleries alone does the value of the recovered by-products exceed the cost of treatment. In the paper mills the value of the materials recovered sometimes offsets the cost of the installation and operation. The canneries still practice lagooning.

The use of industrial wastes in poultry feeding is discussed by C. W. Carrick (120). Both nutrition values and growth promoting substances occur in various wastes from handling organic matter, such as fermentation wastes, antibiotic wastes, fish products, whey waste, beet sugar, and dried vegetables.

At the Battle Creek sewage plant, the heat-drying of sludge had shown a loss (94). From a plant of the Upjohn Company, a waste product from penicillin production was dried under contract and sold as dried penicillin mycilium (D-P-M) for inclusion in hog, chicken, and horse feed. The production of DPM has increased from 30 to 100 tons per month.

C. F. Paulson discussed profits from metal wastes and claims (121) that a new ion-exchange process recovers Chromic Acid and demonstrates other operating advantages. The system consists of a cation exchanger to remove metallic cations from the strong chromic acid anodizing solution and an anion exchanger to recover the chromate from the dilute rinse solutions.

Industrial Waste Surveys

An interesting bulletin (122) on planning and making industrial waste surveys has been prepared by the Ohio River Valley Water Sanitation Commission, with detailed instructions for measuring volumes of flow, obtaining representative samples and calculating waste load. Sampling and measurement of industrial wastes is also discussed by H. H. Black (123).

Among the surveys of industrial wastes is the report (22) of the New

England Interstate Water Pollution Control Commission which supplements its first report (Textile Wastes, A Review 1936-1950, published December, 1950). Included in the current survey were 2,775 plants, of which 1,939 had processes resulting in industrial wastes. Based on the number of employees, the largest industry is the metal industry, the next largest the textile. The total industries are classified under 9 heads plus all other industries, with varied types of wastes. Many are discharged into municipal sewers. The total pollution load discharging to waterways is estimated at 4,934,820 equivalent population, of which 93.4% is untreated. The total load discharging to municipal sewers is estimated at 4,605,530 equivalent population. The report is largely of a statistical nature and indicates the problem in the six New England states.

The subject of Industrial Wastes was thoroughly reviewed by the FSIWA Committee on Research in its Critical Review of the Literature of 1951 (1), citing 164 references, indicating the general interest in the problem, which has been augmented by the general drive throughout the United States to clean up industrial wastes.

A survey of legislation and regulations by states of pollution laws affecting industry has been prepared by M. D. Weiss and published as a reference book of 142 pages (124).

A useful bibliography and abstracts of articles relating to slaughter-house and packing-house wastes has been prepared by D. D. Gold (125).

The problems of radioactivity in waste disposal are summarized in detail (Critical Review of Literature, 1951) by the FSIWA Committee on Research (1), and 94 references are cited. F. W. Kittrell (126) has given a number of examples showing the effect of disposal of radioisotopes in sewers. Maximum permissible concentrations are given.

Effect of Industrial Wastes on Sewage Works Operation

While most sewage works have at least minor difficulties resulting from industrial wastes, they become a major problem at some plants located in heavily industrialized areas. An example is the sewage treatment plant at Niagara Falls, N. Y., where E. J. Smith has described the effects of chemical industry wastes (127). Chemical industries contribute 60 mgd. The plant operation is disrupted primarily by wastes which are not soluble in water and wastes having a high chlorine demand and also by chemical gases which are physically soluble in water in small percentages but are readily released by turbulence.

SEWAGE SERVICE CHARGES

It has become increasingly important for those who design, finance, and operate sewage treatment facilities to arrive at a fair system of charges in proportion to benefits received. As more and more wet industries discharge their strong wastes into municipal sewerage systems (69% of industries now do so) (128), it is irrational to base charges against these industries wholly on either the value of their property or their load on the sewage system. A fair compromise must be worked out.

A fair system of charges is the subject of that significant report issued last year, "Fundamental Considerations in Rates and Rate Structures for Water and Sewage Works," by a committee of the ASCE, the American Bar Association, and other cooperating groups. This report was discussed in the 1951 report of this Committee and was the subject of a panel discussion at

the October, 1951 Meeting of the ASCE in New York City (129).

G. J. Schroepfer (130) and T. M. Niles (131) discuss the determination of fair sewage service charges for industrial wastes and illustrate the procedure involved by hypothetical cases, using the recommendations of the joint committee report referred to in the preceding paragraph. Mr. Niles mentions the contract entered into between the Sanitary District of Decatur and the A. E. Staley Manufacturing Company, calling for payment by the industry of its fair share of the total annual Sanitary District costs including operation, maintenance and minor improvements, administration, bonds, and interest. This industry contributes a high proportion of the total suspended solids and B.O.D. load on the District treatment works. Prior to this contract, the Sanitary District obtained all of its required revenue by tax levy, under which this industry paid about $8,000 annually. Under the new contract, computations based on an analysis of the costs and benefits of the system resulted in allocation of about 50% of the total annual cost to use, and about 50% to the public and property benefits, and the annual payment from this industry will approach $35,000. Had the charge been based on proportionate use alone, it would have been about the latter amount. Neither extreme would be fair.

N. C. Seidenberg (80) has reviewed the subject of special charges for treatment of industrial wastes from the standpoint of an attorney for the Peoria Sanitary District. He divides the wastes into two classes: (a) those such as distilling industry--beer stillage which by evaporation and drying are recoverable as by-products at a substantial profit; (b) other wastes which cannot by any known economical process be recovered as by-products, such as those from breweries, meat-packing houses, paper mills, dairies, creameries, canneries, and laundries, all of which result after the industries have made all reasonable process adjustments. Of class (a) practically none enter the sewer system. With class (b) an increasing amount enters the sewers - until in 1951, it furnished more than 50% of the load on the Peoria treatment plant. An industrial waste rate was fixed by ordinance, but the majority of the invoices sent remain unpaid.

O. J. Muegge (132) lists various industries in Wisconsin which have contributed to the cost of sewage treatment plants, including cheese products, canneries, and dairy products.

D. Metzler (133) describes how an industry and city officials are cooperating to solve a mutual problem of waste treatment at Sabetha, Kansas (population 2400). A cooperative creamery has agreed to pay the city $85.000 to help build a new waste treatment plant to be owned and operated by the city. The volume of flow from the creamery was estimated to be nearly equal to that from the city, but the strength in terms of B.O.D. from the creamery was about three times that from the city. The total treatment works construction cost was approximately $140,000.

Respectfully submitted,

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COMMITTEE ON SEWERAGE AND SEWAGE TREATMENT

September 8, 1952.

APPENDIX

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